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Application of Cognitive-behavioral Therapy in Obstructive Sleep Apnea: Comparison of CPAP Therapy and CBT on the Executive Functions of the Brain

Maryam Talebi[1]*, Kazem Rasoolzadeh Tabatabaye[1] and Ensiye Vahedi[2]

[1]*Tarbiat Modares University, Tehran, Iran*
[2]*School of Medical Sciences, Baqiyatallah University of Medical Sciences, Tehran, Iran*

Abstract

Purpose: Sleep apnea disorder brings about negative effects to the quality of life of the people involved. Debilitation of cognitive functioning is one of the consequences of this condition. Scant researches have been carried out to explore the efficacy of cognitive therapy on mitigating clinical symptoms and cognitive functions of the brain. The novelty of the present study is in combining cognitive method and medical treatment. This research aims to compare the effectiveness of continuous positive air pressure (CPAP) therapy and cognitive-behavioral treatment (CBT) on improving mental cognitive functions in patients with sleep apnea.

Methods: The study population included all patients referred to the Bahar Sleep Disorders Clinic in Tehran, Iran. The sample consisted of 45 people who were randomly placed into three groups of 15 people (CPAP therapy, cognitive behavioral therapy, and control groups). All three groups were psychologically assessed prior to the intervention. Next, individuals in the cognitive-behavioral group underwent 12 sessions of cognitive training, progressive muscle relaxation, mental visualization, and sleep hygiene. The other group went through CPAP therapy. After the intervention, both groups were assessed psychologically. Data collection instruments included Wisconsin cognitive software, simple Stroop, complex Stroop, continuous performance, polysomnography device, and CPAP devices.

Results: The results indicated that both types of intervention can enhance cognitive functioning; however, a greater efficacy is obtained by combining the two methods compared with the exclusive application of medical treatment.

Conclusion: The authors propose cognitive-behavioral therapy OSA as a complement to medical treatment.

Keywords: Obstructive sleep apnea; CPAP therapy; Cognitive-behavioral therapy; Cognitive functions

Introduction

Sleep is one of the most important natural biological cycles and is featured by a complex pattern. One normally applies the concept of sleep to refer to the effects associated with two circadian (24 hours) and balancing processes such as the adequacy of nocturnal sleep, sleep quantity, and daytime sleepiness.

Sleep is important for two reasons: First, sleep-related complaints are very common among people; second, low sleep quality is considered as an indicator of many psychological diseases [1].

Good quality sleep can lead to mental and physical regeneration of individuals since cellular repair and mental health are dependent on sleep.

The quality and quantity of sleep also affect one's health, and they are always regarded as important factors influencing the quality of life People with sleep disorder are not only characterized by fatigue, but also suffer from a range of complications like those related to cellular repair, defects in learning and memory, increased stress and anxiety, and reduced quality of daily life. Hence, sleep disorder can have detrimental effects on a person›s health and improvement.

According to some researchers, the first damage caused by poor sleep emerges in the ability of brain to plan and organize cognitive functions [2]. Sleep apnea is a common disorder with far-reaching implications for health and it is one of the major consequences of cognitive impairment. Apnea leads to a negative effect on inductive and deductive reasoning, attention, alertness, learning [3] poor performance on the revised version of Wechsler Adult Intelligence Scale [4] psychomotor vigilance task [5,6] repetitive finger-tapping test [7] as well as impaired concentration, problem-solving, and verbal and spatial short-term memory [8]. The prevalence of sleep apnea in adult men is about 3% to 7% and nearly 2% to 5% for adult women [9].

In addition to physical factors underlying sleep disorder, one can point to some psychological roots of this condition including emotional factors, dysfunctional beliefs and attitudes concerning sleep [10,11] as well as behavioral factors such as inadequate sleep hygiene.

People with sleep apnea, due to frequent waking, are unable to enter the phase of rapid eye movement (REM) which is necessary for a good sleep [12] therefore; they experience mental health problems such as anxiety and memory complications. This is because dreams are an opportunity for processing everyday events and a means of memory retention [13]. Dreams provide a ground for, long-term goals, everyday interactions and discharge of anxious emotions.

***Corresponding author:** Maryam Talebi, Student of Psychology, Department of Psychology, Faculty of Humanities, Tarbiat Modares University, Tehran, Iran, Tel: 02182884616; E-mail: m.taleby@modares.ac.ir

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A cohort study on 4 million American soldiers, revealed that 118 thousand individuals had gone through sleep apnea along with other disorders such as depression (21/8%) post-traumatic stress (11/9%) anxiety (16/7%) psychosis (5/1%) and bipolar disorder (3.3%) [14,15].

Bardwell et al. reported that after they controlled severe sleep apneas, the subjects showed symptoms of depression and fatigue. Hence, they suggested that in addition to controlling this disorder, one has to take psychological symptoms and mood complications into account as well [16]. It is worth noting that depression has caused the most prevalent conditions in subjects with sleep apnea [17].

It is also shown that anxiety and depression decrease as a result of continuous positive air pressure (CPAP), but fatigue might be still there and the treatment may not improve it. In fact, intense apnea disorder is associated with the increase of anxiety and depression

Aloia et al. in their research on the cognitive effects of apnea and treatment with continuous positive air pressure demonstrated that consciousness increases after treatment, but there still remains a weakness in terms of cognitive abilities and mental performance. It is clear that many cognitive deficiencies cannot be compensated by medical care alone [18].

In their follow-up study, Bourke et al. observed a decrease in the level of anxiety, depression, and psychological distress after treatment; nevertheless, not that much improvement was found in cognitive function tests. The authors suggested that such improvement requires a longer treatment period [19]. Bourke reported that some cognitive symptoms can be treated but this will not lead to improvement in mood and affection symptoms. The use of ECT after the treatment by CPAP is evidence indicating that some of the cognitive functions and symptoms (e.g. depression) cannot completely be improved through CPAP. After treatment with continuous positive air pressure (CPAP), the symptoms of mental weakness (psychasthenia), evaluated by MMPI-2 test, remained unchanged [20].

In their samples that were treated with CPAP and were mentally trained, Golay et al. observed a considerable progress in improving quality of life compared to the group without education [20]. The faith-based model of health, which emphasizes patients' mental experience of health and their beliefs, produces more stable treatment effects [21]. Therefore, due to the severity of cognitive side effects and considering the important role of cognitive disabilities in the course of this condition, we employed, in addition to medical treatment, cognitive-behavioral approach as a combination therapy to improve executive functions of patients.

Materials and Methods

This study is a quasi-experimental research with pretest and post-test design and a control group. The research population consisted of all individuals who referred to Bahar sleep disorders clinic. To conduct the study, 45 patients with sleep apnea were chosen using purposive sampling and assigned to the control and experimental groups. The criteria for inclusion were: maximum age of 60 years, no psychotic and personality disorder, no substance abuse, lack of sleep medications, observing ethical principles, and willingness to cooperate. Under the supervision of a psychiatrist and assistance of the clinical psychologist, the researcher applied, using Wisconsin Card Sorting Test, simple and complex Stroop, together with continuous performance task, the relevant components of executive functions to clients whose apnea had been diagnosed using polysomnography device. Also, CPAP therapy was conducted for two consecutive months on the patients and cognitive-behavioral therapy was performed in 12 sessions (90 minutes each) on the experimental group. During this period, subjects in the control group did not receive any intervention and were kept in the waiting list so that in case the effectiveness of treatment was proved they might be treated provided they were inclined to. The sessions included the following: one session dealing with mental training and providing information about the disorder, explaining the objectives of education and getting familiar with the members, agreeing on the time and place, stressing the importance of therapy assignments, assessing sleep problems, evaluating beliefs, relaxation training, and constructive worry worksheet; two sessions for training time management strategies; two sessions of training organization and planning, sleep hygiene and scheduling a new sleep program, sleep restriction, refraining from daily naps, food health; two sessions of training prevention techniques; one session given to enhancing patients' motivation and problem solving skills, summing up ideas, explaining the reality of sleep, introducing the cycle of thinking and feeling and behavior, training thought blocking, mental visualization, and not trying in vain to fall asleep (paradoxical intention) as well as applying all previous instructions; several sessions devoted to teaching the techniques of emotional self-regulation; and eventually, some training sessions meant to increase cognitive flexibility, control and coordinate as well as organize behaviors.

Results

Table 1 provides the average pretest and post-test scores in the experimental and control groups. As can be seen, compared with the control group, the post-test scores of the experimental groups have been improved in all indices.

To examine the differences in the linear combination of dependent variables in the experimental and control groups, we drew on Wilks' Lambda [a probability distribution used in multivariate hypothesis testing, especially with regard to the likelihood-ratio test and multivariate analysis of variance (MANOVA)]multivariate test (Table 2). The results of all four tests show that after controlling the pretest factor, there was a significant difference in the linear combination of dependent variables; hence, the group factor had a significant impact.

Table 3 illustrates the results of intergroup effect test which can be used to examine the differences between each dependent variable. The results of Table 3 show that the mean scores of post-test have been significantly changed in all of the dependent variables except for the index of "correct responses (phase 2)."

Having observed that F value has been significant in all of the related indices except for that of "correct answers (phase 2)," we next used Bonferroni (one of several methods used to counteract the problem of multiple comparisons) post hoc test for the other 17 indices whose F value were significant in order to determine those post-test scores of the groups that have gone through significant changes. In other words, Bonferroni test was employed so as to make a mutual comparison between the experimental and control groups.

Discussion

Regarding the two indices of "correct answers (phase 1)" and "correct answers (phase 2)," it was found that the mean of polytherapy group was significantly higher than that of control group; however, there was no significant difference between the medical treatment and control group. Therefore, it can be said that compared to medical treatment, polytherapy was more effective on the indices of "correct answers (phase 1)" and "correct answers (phase 2). Nevertheless, it has to be noted that there was no significant difference between the mean

Variables	Components	Combination Group		Medical Group		Control Group	
Stroop Test		Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
	Correct answers (phase 1)	(74/0) 13/9	(64/0) 53/9	(59/0) 26/9	(63/0) 40/9	(67/0) 20/9	(64/0) 13/9
	Correct answers (phase 2)	(53/0) 9	(63/0) 40/9	(59/0) 06/9	(60/0) 26/9	(59/0) 07/9	(53/0) 01/9
	Correct answers (phase 3)	(41/0) 80/8	(50/0) 41/9	(51/0) 86/8	(59/0) 07/9	(59/0) 73/8	(56/0) 80/8
	Reaction time (phase 1)	(18/0) 98/0	(16/0) 87/0	(19/0) 97/0	(17/0) 93/0	(18/0) 00/1	(16/0) 00/1
	Reaction time (phase 2)	(14/0) 90/0	(13/0) 80/0	(17/0) 91/0	(14/0) 85/0	(16/0) 94/0	(15/0) 92/0
	Reaction time (phase 3)	(19/0) 02/1	(16/0) 90/0	(18/0) 03/1	(16/0) 97/0	(17/0) 03/1	(13/0) 02/1
	Correct answers (list of related words)	32	66/35	32	40/33	66/31	60/31
		(65/2)	(95/1)	(97/2)	(09/2)	(74/2)	(38/2)
	Correct answers (list of unrelated words)	93/30	40/34	73/30	80/32	80/30	00/31
		(57/2)	(29/1)	(63/2)	(11/2)	(30/2)	(77/1)
Emotional Stroop test	Reaction time (list of related words)	(11/0) 89/0	(08/0) 83/0	(14/0) 89/0	(11/0) 86/0	(12/0) 91/0	(10/0) 90/0
	Reaction time (list of unrelated words)	(08/0) 90/0	(06/0) 83/0	(11/0) 88/0	(09/0) 85/0	(12/0) 89/0	(11/0) 88/0
	Average reaction time	(08/0) 85/0	(06/0) 72/0	(07/0) 84/0	(05/0) 78/0	(09/0) 85/0	(06/0) 84/0
	Error of commission	(68/0) 80/4	(77/0) 20/3	(27/1) 73/4	(74/0) 86/3	(97/0) 66/4	(64/0) 46/4
Performance Test	Error of omission	(64/0) 86/3	(74/0) 46/2	(70/0) 06/4	(63/0) 40/3	(70/0) 93/3	(91/0) 86/3
	Completed classes	(09/1) 06/4	(12/1) 46/5	(03/1) 26/4	(26/1) 20/5	(72/0) 33/4	(59/0) 26/4
	Preservation error	20Dec	40/10	13Dec	20Nov	00/13	00/13
		(43/3)	(09/2)	(27/3)	(30/2)	(72/2)	(92/1)
Wisconsin Classification Test							
	Other errors	Jun-13	20Aug	80/12	13Oct	86/12	73/12
		(36/4)	(21/2)	(69/4)	(54/3)	(55/3)	(25/2)
	Failure to maintain a sequence	(12/0) 79/0	(09/0) 55/0	(13/0) 81/0	(12/0) 68/0	(12/0) 81/0	(07/0) 80/0
	Attempt to complete the first pattern	33/18	66/14	73/17	53/15	Jun-19	46/18
		(79/7)	(88/5)	(18/6)	(40/4)	(94/5)	(74/4)

Table 1: Mean and SD of research variables in three groups in the pretest and post-test.

Test	Value	F	DF	Sig	Eta
Stroop	0.133	8.996	12	0	0.635
Emotional Stroop	0.105	18.21	8	0	0.675
Performance	0.122	22.94	6	0	0.65
Wisconsin Classification	0.11	13.27	10	0	0.668

Table 2: Multivariate tests (Wilks' lambda statistics).

of post-tests in the polytherapy and medical treatment groups. As for the indices of "reaction time (phase 1)," "reaction time (phase 2)," and "reaction time (phase 3)," it was indicated that both polytherapy and medical treatment had a significant impact, compared to the control group, and they led to the improvement of the subjects' performance. Specifically, polytherapy showed a significantly better effect than medical treatment. Regarding the four indices of "correct answers (list of related words)," "correct answers (list of unrelated words), "reaction time (list of related words)," and "reaction time (list of unrelated words)," we observed that both polytherapy and medical treatment displayed a significant effect, compared to the control group, and they clearly improved subjects' performance. Moreover, it wasremarkable that polytherapy had a significantly better effect than medical treatment. Based on the indices of "average reaction time," "commission error," and "omission error," subjects' performance was better in both experimental groups than that in the control group. Besides, polytherapy revealed a significantly greater performance than medical treatment. With respect to the indices of "completed classes" and "preservation error," we found that subjects' performance was significantly better in both experimental groups, compared to the control group. Even so, although the performance of polytherapy group was slightly better than the medical treatment group, this did not reveal a significant difference. With regard to the three indices of "other errors," "failure to maintain a sequence," and "attempt to complete the first pattern," it was demonstrated that both polytherapy and medical treatment had a significant effect,

Variables	Dependent Variable	SS	DF	F	Sig.	Eta
Stroop Test	Correct answers (phase 1)	1.574	2	3.586	0.038	0.166
	Correct answers (phase 2)	1.485	2	2.745	0.078	0.132
	Correct answers (phase 3)	2.669	2	4.963	0.012	0.216
	Reaction time (phase 1)	273.46	2	21.672	0	0.546
	Reaction time (phase 2)	229.32	2	27.528	0	0.605
	Reaction time (phase 3)	303.67	2	52.08	0	0.743
	Correct answers (list of related words)	111.48	2	54.602	0	0.742
	Correct answers (list of unrelated words)	83.941	2	32.107	0	0.628
	Reaction time (list of related words)	106.7	2	25.907	0	0.577
Emotional Stroop test	Reaction time (list of unrelated words)	106.83	2	28.547	0	0.6
	Average reaction time	406.85	2	74.16	0	0.792
	Error of commission	13.348	2	23.476	0	0.546
Performance test	Error of omission	14.441	2	11.719	0	0.375
	Completed classes	12.58	2	7.773	0	0.296
	Preservation error	36.877	2	14.226	0	0.435
	Other errors	159.16	2	57.396	0	0.756
	Failure to maintain a sequence	0.408	2	56.619	0	0.754
Wisconsin Classification test	Attempt to complete the first pattern	79.667	2	24.189	0	0.567

Table 3: Intergroup effect test.

compared to the control group, and enhanced subjects' performance. Polytherapy had a significantly better impact than medical treatment in this regard as well.

This study aimed to compare two types of interventions including medical treatment and medical cognitive-behavioral polytherapy in

terms of improving mental executive functions of patients who had referred to a sleep disorder clinic.

The study results indicated that both the medical approach and the polytherapy method were effective in treating apnea symptoms. However, upon comparison, it was observed that the efficacy of polytherapy was significantly greater than medical treatment. This finding is consistent with the studies by [22-29].

According to the results of this study, it seems that, in explaining the effectiveness of cognitive-behavioral therapy, training the skills of cognitive-behavioral therapy is helpful in terms of some executive functions such as attention, reaction time, problem-solving strategies, and control of impulsive behaviors; an objective that can be attained through improving cognitive functioning or increasing cognitive abilities of individuals involved [30]. Given that cognitive functions can be seriously impaired due to apnea disorder, one may compensate for the defects resulting from the disease by properly taking advantage of cognitive-behavioral treatment as a regular therapeutic activity built upon cognitive principles.

This seems an important suggestion because frequent sleep apneas might damage the performance of central neural system and the implementation of many cognitive tasks. It is proposed that if one effectively learn cognitive control skills and sleep hygiene strategies, we can expect that the neural system and cognitive performance will be improved. This is due to the fact that one of the goals of cognitive-behavioral treatment is to make lifestyle interventions so as to enhance recovery and increase cognitive performance. As mentioned in the introduction, although the basis of treatment is to emphasize changing the content of thought and cognitive processes, practically the major focus of treatment is on a number of central issues related to patients' daily life such as sleep hygiene, emotional self-regulation, increasing cognitive flexibility, and controlling as well as coordinating behavior.

Indeed, despite the many benefits of cognitive-behavioral therapy in improving sleep quality, sleep disorders are often addressed by physicians, and psychologists have only occasionally dealt with them. Notwithstanding the psychological complications of this disorder, seldom are sleep medicine specialists familiar with its methods of treatment. Thus, it appears that increasing the knowledge of specialists with regard to the efficacy of cognitive-behavioral methods and encouraging psychologists to cooperate with physicians at sleep clinics will lead to obtaining better results in treating sleep disorders. Besides, one may use this method in sleep clinics as a complement to medical treatment.

Compliance with Ethical Standards

Funding: The authors declared that this study received no financial support

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical approval: The whole procedures on the human participants were approved by the Board of Ethics of the hospital and university.

Informed consent: Oral informed consent was obtained from all the participants of the study.

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